1982 3rd ASCOPE LABORATORIES TEST CORRELATION PROGRAMME ON C.F.R. ENGINE*

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1. INTRODUCTION

During the 2nd Workshop on the ASCOPE Laboratory Test Correlation Programme which was, held in Kuala Lumpur 17 – 18 August 1981, the following consensus was reached among participating laboratories :

- The frequency of the correlation test programme should be increased to twice a year.
- Testing should be carried out at the same day and time specified by the Programme coordinator.
- Testing should be carried out according to the same procedure (bracketing Method).

Member countries taking part in this correlation programme are Indonesia as coordinator with seven laboratories participating, Malaysia with one laboratory, Thailand and the Philippines with two laboratories each. The coordinator in this correlation programme is responsible in preparing the correlation samples and sending them by air to each participating laboratory.

The first part of this programme (3rd Correlation Programme) was started by sending samples in January 1982 and the second part (4th Correlation Programme) was starting by sending samples in March 1982. It will appear in the next publication. After being tested by the participating laboratories, the test result are to be sent to the coordinator for the determination of the standard deviation and other statistical data. Based on these results, conclusions can be drawn about the deviation of laboratory test results and about outliers to be rejected.

For better analysis of the results, for each of the samples for correlation it is also required to report physical and chemical tests such as specific gravity, R.V.P., distillation and lead (TEL) content in the receiving laboratories. This is necessary in order to take into account any possible changes in the sample properties which might have occured during transportation and storage. Also to be observed are ambient and engine operating conditions during the correlation tests. The results of this analysis can then be used as a base for deviations the occurence of outliers and recommendation of remedial steps to be taken.

The method used for testing the samples is the bracketing method, while for rounding the value of the member found during the tests the ASA rules for rounding are used.

The Grubb's rejection criteria with the use of "T" factors is used in evaluating the possible outliers.

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2. CORRELATION PROGRAMME EXECUTION

2.1 Correlation Samples

Lemigas as coordinator, provided and prepared the correlation samples shown in Table 1. The correlation samples were sent to each participating laboratory.
The amount of the correlation sample, was two liters for each grade, put into two one-litre cans; one litre cans were used in order to comply with IATA air transport regulations concerning the maximum fuel container volumes permitted for air transport of inflammable materials.

To facilitate and simplify the conduct of this programme, each sample was coded alpha-numerically according to sample type as follows :
"SC—number", where SC indicates sample code and number indicates sample type.

2.2 Participating Laboratories

The participating laboratories were similarly coded alpha—numerically as follows :

' LC—number", where LC indicates laboratory code and participant's number in this correlation programme.

The list of participating laboratories appears in Table 2.

In order to facilitate communication, laboratories in each country were coordinated through a Country Coordinator. The list of Country Coordinators and the programme coordinator appears in Table 3.

3. SAMPLE PREPARATION

The 1982 Correlation Programme on CFR Engines consists of two parts, i.e. 3rd and 4th CFR Correlation Programmes.

For each part of the programmes the test samples and distribute them to the participating laboratories through their respective country coordinators samples for the first phase (3rd CFR Correlation Programme) were prepared and sent to the participating laboratories in January 1982, while for the second phase (4th CFR Correlation Programme) samples were prepared to be sent in March 1982, and it will appear in the next publications.

In each care, sample preparation consists of five stages, viz :

(1) Acquisition of substances for sample preparation, materials and equipment
(2) Blending of sample
(3) Filling of sample into containers
(4) Packing
(5) Dispatch.

Each of these steps was carried out in the routine manner, but with utmost care, by LEMIGAS as the coordinating laboratory.

4. ROUNDING RULES FOR THE TEST RESULTS

The ASA rules for rounding as pertained to this procedure can be stated simply as follows :

(1) The value of the number is unchanged when the last digit to be dropped is less than 5
(2) The digit proceeding the digit to be dropped is raised by one when the last digit is greater than 5
(3) When the last digit to be dropped is exactly 5 and the digit proceeding it is an even digit, the 5 is dropped without change to the number
(4) When the digit to be dropped is exactly 5 and the digit proceeding it is an odd digit, the digit proceeding is raised by one

Example :

Number Number		Nearest Hundredth	Nearest Tenth
1.	97,642	97,64	97,6
2.	97,237	97,24	97,2
3.	97,355	97,36	97,4
4.	97,985	97,98	98,0

When rounding from three digits to one digit the last two digit to be dropped must be considered together and the rule applies to values greater or less than 50.

97,499	97,4
97,540	97,5
97,551	97,6
97,549	97,5
97,550	97,6

5. PROCEDURE FOR TEST DATA ANALYSIS

Test results are analysed according to the following procedure for calculating basic statistical data for analysis programme results.

The data obtained by this procedure include average of results, average of deviations, standard deviations, and rejection of outliers, which are basic to other statistical treatment such as trend etc.

The data thus obtained also provide sufficient parameters for comparing like data from individual laboratories or groups of laboratories performing the same test. The procedure is presented in a step by step manner to standardize procedure and to simplify the calculations and evaluation. The following steps are taken to calculate the basic statistical data :

- Step I
  Number of results = n
  Results = $X_1, X_2, X_3 \ldots . X_n$
  Sum of results = $n \quad i=1 \quad x_i$

- Step II
  Average of results = $n \quad i=1 \quad X_1 \quad n = X$

- Step III
  Deviation = $X_1 - X$
  Sum of deviation = $n \quad i=1 \quad X_1 - X$
  Average deviation = $n \quad i=1 \quad X_1 - X \qquad n$

- Step IV Deviation squared = $(X_i - X)^2$
- Step V Variance = $n \; i=1 \; (X_i - X)^2$

  $n-1$
- Step VI Standard deviation = variance =

  $n \; (X_c - X)^2$

  $i=1$

  $n - 1$ '
- Step VII Rejection of outliers

  $n \; (X_i - X)^2$

  $i=1$

  "T" factor times standard deviation = $T \times n-1$

In the computation of standard Diviation the use of (n — 1) is statistically more correct than n.

6. TEST RESULTS

6.1 3rd ASCOPE EFR Engine Correlation Programme

The results submitted by the participating laboratories were compiled and evaluated following the procedure described above.

For the 3rd CFR Correlation Programme, results for sample SC—01 are listed in Tables 4, 5, 6, 7, which show respectively the ambient temperature and engine operating conditions, general properties of sample deviation of general properties and calculation (see page 13, through 16)..

Results for sample SC—02 are similarly listed in Table 8, 9, 10, 11 (page 15, through 20).

Similarly, the results for sample SC—03 are shown in Tables 12, 13, 14, 15, (see page 21; through 24)

The results are summarized visualy in Figure 1, 2, 3, which plot the laboratory test results, the average octane number, standard deviations, and rejection of outliers for samples SC —01, SC—02, SC—03, respectively (see page 25 through 27).

7. CONCLUSION

7.1 3rd ASCOPE

From the results of test conducted by all partipating laboratories and the evaluation of standard deviation/rejection of outliers (see Fig 1, Fig 2, Fig 3, Page 25, Page 26,27), the following conclusion can be drawn.

7.1.1 Test Results

Concerning sample SC-01, 3 (three) ratings exceed standard deviation viz, the ratings coming from LC-05, LC-09, LC-12, which are however not to be rejected as outliers being still within acceptable limits based on Grubb's Criterion for 99 percent probability.

Hence, the ratings from all the participating laboratories concerning SC-01 are satisfactory.

Concerning sample SC-02, 3 (three) ratings exceed standard deviation, coming from LC-04, LC-06 and LC-13, which are however still within acceptable limits based on Grubb's Criterion. This means that all test results of sample SC-02 are satisfactory.

Concerning sample SC-03, 2 (two) ratings exceed standard deviation, coming from LC-07 and LC-09 which are however still within aceeptable limits based on Grubb's criterion. This mean that all test results of sample SC-03 are satisfactory.

7.1.2 Inspection Test

The inspection test data can also point out problems with the sample fuel (I.e. poorly mixed, light end loss, poor handling, leaking etc).
According to table 6, 10, 14, there are no significant deviations in the specific gravity, RVP. distilation and TEL content. This means that all correlation samples are stisfactory.

7.1.3. Adherence to the Test Procedure

Although, the test results of the samples SC-01, SC-02, and SC-03 submitted by all the participating laboratories are satisfactory, (none is rejected as outlier), from the data on ambient and engine operating conditions during testing of samples SC-01, SC-02 and SC-03, however it can be seen that one of the participating laboratories has not satisfied the conditions for the correlation of CFR engines. One has deviated from the test procedure estabilished by the ASTM.

Exampie of non-adherence to the procedure is as follows :

Concerning sample SC-01

Participating laboratory LC-02 carried out the test with too large a knock sensitivity viz, 50. This can cause inaccuracies in acquiring the octane number by interpolation. According to the ASTM Manual for octane numbers lower than 100 the sensitivity to be used is about 30 or less.

7.2 Test Results

Concerning sample SC-01, 3 (three) rating exceed standard deviation viz, the ratings coming from LC-05, LC-07, LC-10 which are however not to be rejected as outliers being still within acceptable limits based on Grubb's Criterion for 99 percent probability.

Hence, the ratings from all the participating laboratories concerning SC-01 are satisfactory.

Concerning sample SC-02, 2 (two) ratings exceed standard deviation, coming from LC-02 and LC-04, which are however still within acceptable limits based on Grubb's Criterion.

Hence, the ratings from all the participating laboratories concerning SC-02 are satisfactory. Concerning sample SC-03, 2 (two) ratings exceed standard deviation coming from LC-07 and LC-09, which are however still within acceptable limits based on Grubb's Criterion. This means that all the test results of sample SC-03 are satisfactory.

7.2.1. Inspection Tests

According to our conclusion on the third Ascope laboratory test Correlation Programme Gravity, RVP and TEL content. This means that all correlation samples are satisfactory.

7.2.2. Adherence to the Procedure.

Although the test resulrs of the samples SC-01, SC-02 and 03 submitted by all the participating laboratories are satisfactory (none is rejected as outlier), from the data on ambient and engine operating conditions during testing of SC-01, SC-02 and SC-03, however, can be seen that one of the participating laboratories has not satisfied the standard operating conditions for correlation of CFR engine.

(1) Concerning Sample SC-01

Participant laboratory LC-02 carried out the test with micrometer setting at 0,453 in. According to Table 2 of the ASTM Manual, for knock rating at 99,0 octane number, the micrometer setting has to be about 0,377 in.

(2) Concerning Sample SC-02

Participant laboratory LC-02 carried out the test with micrometer setting at 0, 598 in.

According to Table 2 of ASTM Manual for knock rating at 89,0 octane number, the micrometer setting has to be about 0,507 in.

(3) Concerning Sample SC-03

Participant laboratory LC-02 carried out the test with micrometer setting at 0,638 in. According to table 2 of ASTM Manual for knock rating at 84,7 octane number, the micrometer setting has to be about 0,546 in.

7.3 GENERAL CONCLUSION

From observation of the test of all the correlation samples and participating laboratories, it can be concluded that the maximum and minimum deviation of all the ratings are still within acceptable limits on the basis of Grubb's Criterion for 99 percent probability. It means that none of the test results are rejected.
Concerning the evaluation of ratings exceeding standard deviation from 1st Programme (1980) to 4th Programme (1982) for sample SC-01, SC-02, SC-03, the precentage of ratings exceeding standard deviation has decreased which shows that the Programmes are succesful in improving the performance of the participating laboratories.

Some participants however are still persisting in no-adherence to the ASTM Procedure.

List of Literature

1. Annual Book of ASTM Standards 1980
2. Ethyl Cooperation Technical Services Laboratories (1974)
3. Comite De La Detonation La Measure De L' indice D' Octane

Table 1

3rd ASCOPE Laboratory Test Correlation Programme on CFR Engines (1982)

Types and Codes of Sample

Type	Grade	Code
1. Commercial	Fuel High Grade	SC—01
2. Commercial	Fuel Low Grade	SC—02
3. Standardization	Toluene—Heptane	SC—03

Table 2

3rd ASCOPE LABORATORY TEST CORRELATION PROGRAMME ON CFR ENGINES (1982)

List of Participating Laboratories

Country	Laboratory
Indonesia	(1) Pertamina Refining Unit I Lab. Pangkalan Brandan
	(2) Pertamina Refining Unit II Lab. Dumai
	(3) Pertamina Refining Unit III Lab. Plaju
	(4) Pertamina Refining Unit III Lab. Sungai Gerong
	(5) Pertamina Refining Unit IV Lab. Cilacap
	(6) Pertamina Refining Unit V Lab. Balikpapan
	(7) Lemigas Oil and Gas Technology Development Centre P.O. Box 89 JKT Jakarta

Country	Laboratory
Malaysia	(1) ESSO Malaysia Berhad Port Dickson Att. : Mr. John J. Degouff Refinery Manager
Philippines	(1) Bataan Refining Corporation (BRC) P.O. Box 1035 MCC Makati Metro Manila
	(2) Petrophil Corporation Pandacan Laboratory P.O. Box 1031 MCC Makati Metro Manila
Thailand	(1) Defence Energy Department Bangchak Refinery Laboratories Bangchak Bangkok
	(2) Science Division Oil Distribution and Supply Petroleum Authority of Thailand Prakanong Bangkok

Table 3

3rd ASCOPE Laboratory Test Correlation Programme on CFR Engines (1982)

List of Country Coordinators

Country	Coordinator
Indonesia	Mr. Bustani Mustafa PPTMGB "LEMIGAS" P.O. Box 89/JKT Jakarta
Malaysia	Mr. Jejakumar Thangarajah Refinery Project Department Processing and Manufacturing Division Petronas, P.O. Box 2444 Bangunan MIDF, 195 A, Jalan Pakeliling Kuala Lumpur Telex : Petron MA 30839
Philippines	Mr. R.S. Bernardo Petrophil Corporation 7901 Makati Avenue Makati Metro Manila Telex : 22259 PNO PH, 45270 PNOC PM
Thailand	Mr. Sawaeng Boonyasuwat Science Department Office of Oil Distribution and Supply Petroleum Authority of Thailand Prakanong Bangkok Telex : 87940 NGOT TH
Programme Coordinator	Mr. E. Jasjfi PPTMGB "LEMIGAS" P.O. Box 89/JKT Jakarta.

Table 4

3RD ASCOPE LABORATORY TEST CORRELATION PROGRAMME FOR CFR ENGINES (1982)

Test Conditions Sample No. SC–01

Lab. No.		LC–01	LC–02	LC–03	LC–04	LC–05	LC–06	LC–07	LC–08	LC–09	LC–10	LC–11	LC–12	LC–13
Motor Number		3	4–62 1131197	E–1815	1131181	F–1	752148/ 6718	207441		1104652	G 37747	9–69 178812	6–72 230541	CFR–48
Total Hours		3303.2	–	6537,2	5265	1224.2	3935	1232.8		–	1430.4	1635	2811	–
Running Hours after Last Overhaul		84.6	10	223	200	71.1	63	13.8		170.6	1430.4	134	200	117
Use Ice Tower, Yes/No		No	Yes	Yes	Yes	Yes	Yes	Yes		Yes	No	Yes	Yes	Yes
Intake Air Temperature, °F		125	125±1	125	126	125	122	125		127	125	125	125	125
Ambient Temperature, °C		29.5	29	29.9	25	26	32	30		26.1	30	26	20–30	25.1
Barometric Pressure, mm Hg		764.0	765.5	760	762	763	753	761.2		765.1	760	760	750	760
RPM		598	600	600	600	600	600	600		598	600	600	600	600
Altitude, m		3.65	2.5	3.65	5	4.2	3.5	4		41	6	7.5	±4	0
Knockmeter Sensitivity		18	50	13	28	19	22	25		12	26	29	21	38
Cylinder Position	DC													850
	MS	0.398	0.399	0.402	0.415	0.407	0.404	0.503		0.414	0.405	0.417	0.397	

Table 5
3rd ASCOPE LABORATORY TEST CORRELATION PROGRAMME
FOR CFR ENGINES (1982)
Test Results Sample No. S.C. - 01

Lab. No.	LC–01	LC–02		LC–04	LC–05	LC–06	LC–07	LC–08	LC–09	LC–10	LC–11	LC–12	LC 13	Average
Motor Number	3	4–62 1131197	E–1815	1131181	F–1	752148/ 6718	207441		1104652	G 37747	9–69 178812	6–72 230541	CFR–48	
Knock Rating F–1 ON ASTM D–2699	97.7	97.3	97.8	97.2	98.0	97.8	97.2		96.9	97.4	97.4	98.0	97.7	97.5
Spec. Gravity 60/60° °F ASTM D–1298	0.7548	0.7563	0.7555	0.7543	0.756	0.7544	0.7627		0.7543	7545	0.7555	0.7571	0.756	0.7560
RVP, ASTM D–323 psi	7.1	7.2	7.2	7.5	7.1	7.25	7.3		7.6	7.6	7.5	6.9	6.9	7.3
Distillation ASTM D–86														
IBP °C	39	36	44	40	41	43	45.5		41	40	42	43	39	41.1
10% °C	61	59.5	62	63	62	68	65.5		61	60	63	64	60	62.4
°C	100	98	97	99	99	98	100		98	97	100	99	98	98.6
90% °C	147	143	144	145	147	145	143		143	144	141	143	142	143.9
EP °C	183	187.5	181	177	183	180	179		175	176	184	184	190	181.6
TEL Content, ml/USG ASTM D–526/IP–116	2.59	2.60	2.50	0.77	2.82	0.84	3.57		2.48	2.59	2.61	1.22	2.65	2.27

Note : LC–02 : TEL Content = 2.60 ml/USG (ASTM D–3341)
LC–07 : TEL Content = 3.57 ml/USG (AAS)
LC–09 : TEL Content = 2.48 ml/USG (ASTM D–2547)
LC–13 : TEL Content = 0.75 gm/litre (ASTM D–3441)

Table 6

3rd ASCOPE LABORATORY TEST CORRELATION PROGRAMME FOR CFR ENGINES (1982)

Deviation of General Properties Sample (SC–01)

Determination	LC–01	LC–02	LC–03	LC–04	LC–05	LC–06	LC–07	LC–08	LC–09	LC–10	LC–11	LC–12	LC–13
Specific Gravity 60/60°F	– 0.0012	+ 0.0003	– 0.0005	– 0.0017	0.0	– 0.0016	+ 0.0067		– 0.0017	– 0.0015	– 0.0005	+ 0.0011	0.0
R.V.P. psi	– 0.2	– 0.1	– 0.1	+ 0.2	–0.2	– 0.05	0.0		+ 0.3	+ 0.3	+ 0.2	– 0.4	– 0.4
Distillation													
I.B.P. °C	– 2.1	– 5.1	+ 2.9	–1.1.	– 0.1	+ 1.9	+ 4.4		– 0.1	– 1.1	+ 0.9	+ 1.9	– 2.1
10% °C	– 1.4	– 2.9	– 0.4	+ 0.6	–0.4	+ 5.6	+ 3.1		– 1.4	– 2.4	+ 0.6	+ 1.6	– 2.4
50% °C	+ 1.4	– 0.6	– 1.6	+ 0.4	+ 1.4	– 0.6	+ 1.4		– 0.6	– 1.6	+ 1.4	+ 0.4	– 0.6
90% °C	+ 3.1	– 0.9	+ 0.1	+ 1.1	+ 3.1	+ 1.1	– 0.9		– 0.9	+ 0.1	– 2.9	– 0.9	–1.9
E.P. °C	+ 1.4	+ 5.9	– 0.6	– 4.6	+ 1.4	– 1.6	– 2.6		–6.6	– 5.6	+ 2.4	+ 2.4	+ 8.4
T.E.L. Content ml/USG	+ 0.32	+ 0.33	+ 0.23	– 1.50	+ 0.55	– 1.43	+ 1.30		+ 0.21	+ 0.32	+ 0.34	– 1.05	+ 0.38

Table 7

3RD ASCOPE LABORATORY TEST CORRELATION PROGRAMME

FOR CFR ENGINES (1982)

Calculation SC–01

Col. A Laboratory	Motor Number F–1	Col. B Octame Number	Col. C Deviation of Average	Col. D Deviation squared
LC–01	3	97.7	+ 0.2	0.04
LC–02	4–62–1131197	97.3	– 0.2	0.04
LC–03	E–1815	97.8	+ 0.3	0.09
LC–04	1131181	97.2	– 0.3	0.09
LC–05	F–1	98.0	+ 0.5	0.25
LC–06	752148/6718	97.8	+ 0.3	0.09
LC–07	207441	97.2	– 0.3	0.09
LC–08				
LC–09	1104652	96.9	– 0.6	0.36
LC–10	G 37747	97.4	– 0.1	0.01
LC–11	9–69–178812	97.4	– 0.1	0.01
LC–12	6–72–230541	98.0	+ 0.5	0.25
LC–13	CFR–48	97.7	+ 0.2	0.04
	Sum	1170.4	3.6	1.36
	No. of Results (n)	12	12	12

Step 1 :

Average Octane Number $= \frac{\text{sum of results}}{\text{no of results}} = \frac{1170.4}{12} = 97.5$

Step 2 :

Average Deviation $= \frac{\text{sum of deviation}}{\text{no of deviation}} = \frac{3.6}{12} = 0.3$

Step 3 :

Variance $= \frac{\text{sum of dev. squared}}{(\text{no of dev. squared} - 1)} = \frac{1.36}{12-1} = \frac{1.36}{11} = 0.12$

Step 4 :

Standard Deviation = square root of variance $= \sqrt{\text{variance}} = \sqrt{0.12} = 0.35$

Step 5 :

Rejection of Outliers = "T" factor X std. deviation = 2.55 X 0.35 = 0.89.

Table 8

3RD ASCOPE LABORATORY TEST CORRELATON PROGRAMME FOR CFR ENGINES (1982)

Tets Conditions Sample No. SC-02

Lab. No.		LC–01	LC–02	LC–03	LC–04	LC–95	LC–06	LC–07	LC–08	LC–09	LC–10	LC–11	LC–12	LC–13
Motor Number		3	4–62 1131197	E–1815	1131181	F–1	7521487 6718	207441		1104652	G 37747	9–69 178812	6–72 230541	CFR–48
Total Hours		3301.7		6535.7	5264	1226.3	3936.5	1233.8			1431.6	1635	2813.5	
Running Hours after Last Overhaul		83.1	10	221.5	199	72.3	64.5	14.8		171.2	1431.6	134	202.5	118
Use Ice Tower, °F Yes No		No	Yes	Yes	Yes	Yes	Yes	Yes		Yes	No	Yes	Yes	Yes
Intake Air Temperature, °F		125	125 ± 1	125	126	125	123	125		127	125	125	125	125
Ambient Temperature, °C		28.5	29	29.9	25	26	32	30		26.1	30	26	20–30	25.1
Barometric Pressure, mm Hg		763.1	765.5	760	762	764	753	761.2		765.1	760	760	756	760
RPM		598	600	600	600	600	600	600		598	600	600	600	600
Altitude, m		3.65	2.5	3.65	5	4.2	3.5	4		41	6	2.5	± 4	0
Knockmeter Sensitivity		21	22	20	28	18	18	20		12	19	15	15	14
Cylinder Position	DC													676
	MS	0.524	0.548	0.525	O.536	0.530	O.528	0.526		0.530	0.528	0.544	O.525	

Table 9

3rd ASCOPE LABORATORY TEST CORRELATION PROGRAMME FOR CFR ENGINES (1982)

Test Results Sample No. S.C.–02

Lab. No.	LC–01	LC–02	LC–03	LC–04	LC–05	LC–06	LC–07	LC–08	LC–09	LC–10	LC–11	LC–12	LC–13	Average
Motor Number	3	4–62 1131197	E–1815	1131181	F–1	752148/ 6718	207441		1104652	G 37747	9–69 178812	6–72 230541	CFR–48	
Knock Rating F-1 ASIM D-2299	86.9	86.5	86.9	86.4	86.7	87.0	86.5		86.5	86.6	86.8	86.9	86.4	86.7
Spec. Gravity 60/60°F ASIM D-1298	0.7303	0.729	0.7305	0.7275	0.730	0.729	0.7302		0.7279		0.7286	0.7305	0.728	0.7292
RVP, ASTM D-323 psi	6.8	7.4	6.8	7.4	7.0	7.05	7.2		7.6	7.1	7.3	6.9	7.2	7.1
Distillation ASTM D-86														
IBP °C	42	39.5	44	39	40	39	42		41	43	42	44	43	41.5
10% °C	62	61	63	62	62	60	61		60	61	61	65	61	61.6
50% °C	95	93	93	94	94	93.5	93		93	93	94	94	93	93.5
90% °C	135	132.5	134	132	135	135	130		134	132	134	133	135	133.5
EP °C	165	166.5	168	157	161	165	155.5		158	160	161	162	158	161.4
TEL Content, ml/USG ASTM D-526/IP-116	2.40	2.37	2.42	2.38	2.70	2.39	2.2		2.14	2.44	2.4	2.45	2.46	2.39

Note : LC–02 :TEL Content = 2.37 ml/USG (ASTM D-3341)
LC–07 : TEL Content = 2.2 ml/USG (AAS)
LC–09 : TEL Content = 2.14 ml/USG (ASTM D-2547)
LC–13 : TEL Content = 0.69 gm/litre (ASTM D-3341)
= 0.69 x 0.946 x 3.785 = 2.46 ml/USG.

Table 10
3rd ASCOPE LABORATORY TEST CORRELATION PROGRAMME FOR CFR ENGINES (1982)
Deviation of General Properties Sample (SC-02)

Determination		LC−01	LC−02	LC−03	LC−04	LC−05	LC−06	LC−07	LC−08	LC−09	LC−10	LC−11	LC−12	LC−13
Specific Gravity 60/60°F		+0.0011		−0.0013	−0.0017	+0.0008	−0.0002	+0.0010		−0.0013	0.0	−0.0006	+0.0013	−0.0012
R.V.P.	pci	−0.3	+0.3	−0.3	+0.3	−0.1	−0.05	+0.1		+0.5	0.0	+0.2	−0.2	+0.1
Distillation I.B.P.	°C	+0.5	−2.0	+2.5	−2.5	−1.5	−2.5	+0.5		−0.5	+1.5	+0.5	+2.5	+1.5
10%	°C	+0.4	−0.6	+1.4			−1.6	−0.6		−1.6	−0.6	−0.6	+3.4	−0.6
50%	°C	+1.5	−0.5	−0.5	+0.5	+0.5	0.0	−0.5		−0.5	−0.5	+0.5	+0.5	−0.5
90%	°C													
E.P.	°C	+3.6	+5.1	+6.6	−4.4	−0.4	+3.6	−5.9		−3.4	1.4	−0.4	+0.6	−3.4
T.E.L. Content ml/USG		+0.01	−0.02	+0.03	−0.01	+0.31	0.0	−0.19		−0.25	+0.05	+0.01	+0.06	+0.07

Table 11

3RD ASCOPE LABORATORY TEST CORRELATION PROGRAMME FOR CFR ENGINES (1982)

Calculation SC-02

Col. A Laboratory	Motor Number F-1	Col. B Octane Number	Col C Deviation of Average	Col. D Deviation squared
LC–01	3	86.9	+0.2	0.04
LC–02	4–62–1131197	86.5	–0.2	0.04
LC–03	E–1815	86.9	+0.2	0.04
LC–04	1131181	86.4		0.09
LC–05	F–1	86.7	0.0	0.0
LC–06	752148/6718	87.0	+0.3	0.09
LC–07	207441	86.5	–0.2	0.04
LC–08				
LC–09	1104652	86.5	–0.2	0.04
LC–10	G 37747	86.6	–0.1	0.01
LC–11	9–69–178812	86.8	+0.1	0.01
LC–12	6–72–230541	86.9	+0.2	0.04
LC–13	CFR–48	86.4	–0.3	
	Sum	1040.1	2.3	0.53
	No. of Results (n)	12	12	12

Step 1 :
Average Octane Number : $\frac{\text{sum of results}}{\text{no. of results}} = \frac{1040.1}{12} = 86.7$

Step 2 :
Average Deviation : $\frac{\text{sum of deviation}}{\text{no. of deviation}} = \frac{2.3}{12} = 0.19$

Step 3 :
Variance : $\frac{\text{sum of dev. squared}}{\text{(no. of dev.squared - 1)}} = \frac{0.53}{12-1} = \frac{0.53}{11} = 0.05$

Step 4 :
Standard Deviation : square root of variance $\sqrt{=}$ variance $= \sqrt{0.05} = 0.22$

Step 5 :
Rejection of Outliers : "T" factor X std. deviation = 2.55 x 0.22 = 0.56

All results are not rejected.

Table 12
3RD ASCOPE LABORATORY TEST CORRELATION PROGRAMME
FOR CFR ENGINES (1982)
Test Conditions Sample SC-03

Lab. No.		LC–01	LC–02	LC–03	LC–04	LC–05	LC–06	LC–07	LC–08	LC–09	LC–10	LC–11	LC–12	LC–13
Motor Number		3	4–62 1131197	E–1815	1131181	F–1	752148/ 6718	207441		1104652	G 37747	9–69 178812	6–72 230541	CFR–48
Total Hours		3302.3	—	6536.5	5263	1227.3	3938	1234.8		—	1432.2	1635	2815	—
Running Hours after Last Overhaul		83.7	10	223.3	198	73.9	66	15.8		171.7	1432.2	134	204	119
Use Ice Tower, Yes/No		No	Yes	Yes	Yes	Yes	Yes	Yes		Yes	No	Yes	Yes	Yes
Intake Air Temperature, °F		125	125 ± 1	125	126	125	124	125		127	125	125	125	125
Ambient Temperature,														
Barometric Pressure, mm Hg		764.0	765.5	760	762	763	753	761.2		765.1	760	760	756	760
RPM		598	600	600	600	600	600	600		598	600	600	600	600
Altitude,	m	3.65	2.5	3.65	5	4.2	3.5	4		41	6	2.5	± 4	0
Knockmeter Sensitivity		19	tak terbaca	17	28	16	18	23		12	18	16	26	12
Cylinder Position	DC													656
	MS	0.545	0.570	0.547	0.553	0.543	0.547	0.545		0.550	0.546	0.573	0.543	

Table 13
3rd ASCOPE LABORATORY TEST CORRELATION PROGRAMME
FOR CFR ENGINES (1982)
Test Results Sample No. S.C. – 03

Lab No.	LC–01	LC–02	LC–03	LC–04	LC–05	LC–06	LC–07	LC–08	LC–09	LC–10	LC–11	LC–12	LC–13	Average
Motor Number	3	4–62 1131197	–1815	1131181	F–1	752148/ 6718	207441		1104652	G 37747	9–69 178812	6–72 230541	CFR–48	
Knock Rating F–1 ON ASTM D–2699	84.7	84.8	84.5	84.6	85.0	84.8	85.2		84.1	84.7	84.8	84.8	84.7	84.7
	0.8063	0.8086		0.8087		0.8072	0.8071		0.8054	0.8066	0.809	0.8086	0.808	0.8074
RVP, ASTM D–323 psi	1.3	1.4	1.2	1.6	0.7	1.2	1.7		2.0	1.6	1.2	1.4	1.3	1.4
Distillation ASTM D–86														
IBP °C	100	99.5	98	100	100	99.5	100		99	100	100	98	100	99.5
10% °C	102	102.5	102	103	103	102	101.5		101	102	103	102	102	102.2
50% °C	104	104.0	104	105	104	104	103		103	104	104	104	104	103.9
90% °C	107	107.5	107	109	108	108.5	106.5		107	107	108	107		107.5
EP °C	115	132.6	116	120	123	130.5	108		117	122	133	132	120	122.4
TEL Content, ml/USG ASTM D–526/IP–116	Nil	Nil	Nil	—	Nil	0.01	0.02		Nil	0.07	Nil	Nil	Nil	0.009

Note : LC–07 : TEL Content = 0.02 ml/USG (AAS).

Table 14

3rd ASCOPE LABORATORY TEST CORRELATION PROGRAMME

FOR CFR ENGINES (1982)

Deviation of General Properties Sample (SC–03)

Determination	LC–01	LC–02	LC–03	LC–04	LC–05	LC–06	LC–07	LC–08	LC–09	LC–10	LC–11	LC–12	LC–13
Specific Gravity 60/60°F.	−0.0011	+0.0012	−0.0002	−0.0007	+0.0006	−0.0002	−0.0003		−0.0020	−0.0008	+0.0016	+0.0012	+0.0006
R.V.P psi	−0.1	0.0	−0.2	+0.2	−0.7	−0.2	+0.3		+0.6	+0.2	−0.2	0.0	−0.1
Distillation I.B.P. °C	+0.5	0.0	−1.5	+0.5	+0.5	0.0	+0.5		−0.5	+0.5	+0.5	−1.5	
10% °C	−0.2	+0.3	−0.2	+0.8	+0.8	−0.2	−0.7		−1.2	−0.2	+0.8	−0.2	−0.2
50% °C	+0.1	+0.1	+0.1	+1.1	+0.1	+0.1	−0.9		−0.9	+0.1	+0.1	+0.1	+0.1
90% °C	−0.5	0.0	−0.5	+1.5	+0.5	+1.0	−1.0		−0.5	−0.5	+0.5	−0.5	−0.5
E.P. °C	−7.4	+10.2	−6.4	−2.4	+0.6	+8.1	−14.4		−5.4	−0.4	+10.6	+9.6	−2.4
T.E.L. Content ml/USG	−0.009	−0.009	−0.009		−0.009	−0.001	+0.011		−0.09	+0.061	−0.009	−0.009	−0.009

Table 15

3RD ASCOPE LABORATORY TEST CORRELATION PROGRAMME FOR CFR ENGINES (1982)

Calculation SC-03

Col. A Laboratory	Motor Number F-1	Col B Octane Number	Col. C Deviation of Average	Col. D Deviation squared
LC–01	3	84.7	0.0	0.0
LC–02	4–62–1131197	84.8	+0.1	0.01
LC–03	E–1815	84.5	–0.2	0.04
LC–04	1131181	84.6	–0.1	0.01
LC–05	F–1	85.0	+0.3	0.09
LC–06	752148/6718	84.8	+0.1	0.01
LC–07	207441	85.2	+0.5	0.25
LC–08				
LC–09	1104652	84.1	–0.6	0.36
LC–10	G 37747	84.7	0.0	0.0
LC–11	9–69–178812	84.8	+0.1	0.01
LC–12	6–72–230541	84.8	+0.1	0.01
LC–13	CFR–48	84.8	0.0	0.0
	Sum	1016.7	2.1	0.79
	No. of Results (n)	12	12	12

Step 1 :
Average Octane Number

$$\frac{\text{sum of results}}{\text{no. of results}} = \frac{1016.7}{12} = 84.7$$

Step 2 :
Average Deviation

$$\frac{\text{sum of deviation}}{\text{no. of deviation}} = \frac{2.1}{12} = 0.18$$

Step 3 :
Variance

$$\frac{\text{sum of dev. squared}}{\text{(no. of dev - squared - 1)}} = \frac{0.79}{(12\text{-}1)} = \frac{0.79}{11} = 0.07$$

Step 4 :
Standard Deviation

$$\text{square root of varience} = \sqrt{\text{variance}} = \sqrt{0.07} = 0.26$$

Step 5 :
Rejection of Outliers

"T" factor X std. deviation = 2.55 x 0.26 = 0.66

All result are not rejected.

FIG. 1

DEVIATION vs LAB. CODE (SC – 01)

CFR 3rd CORRELATION

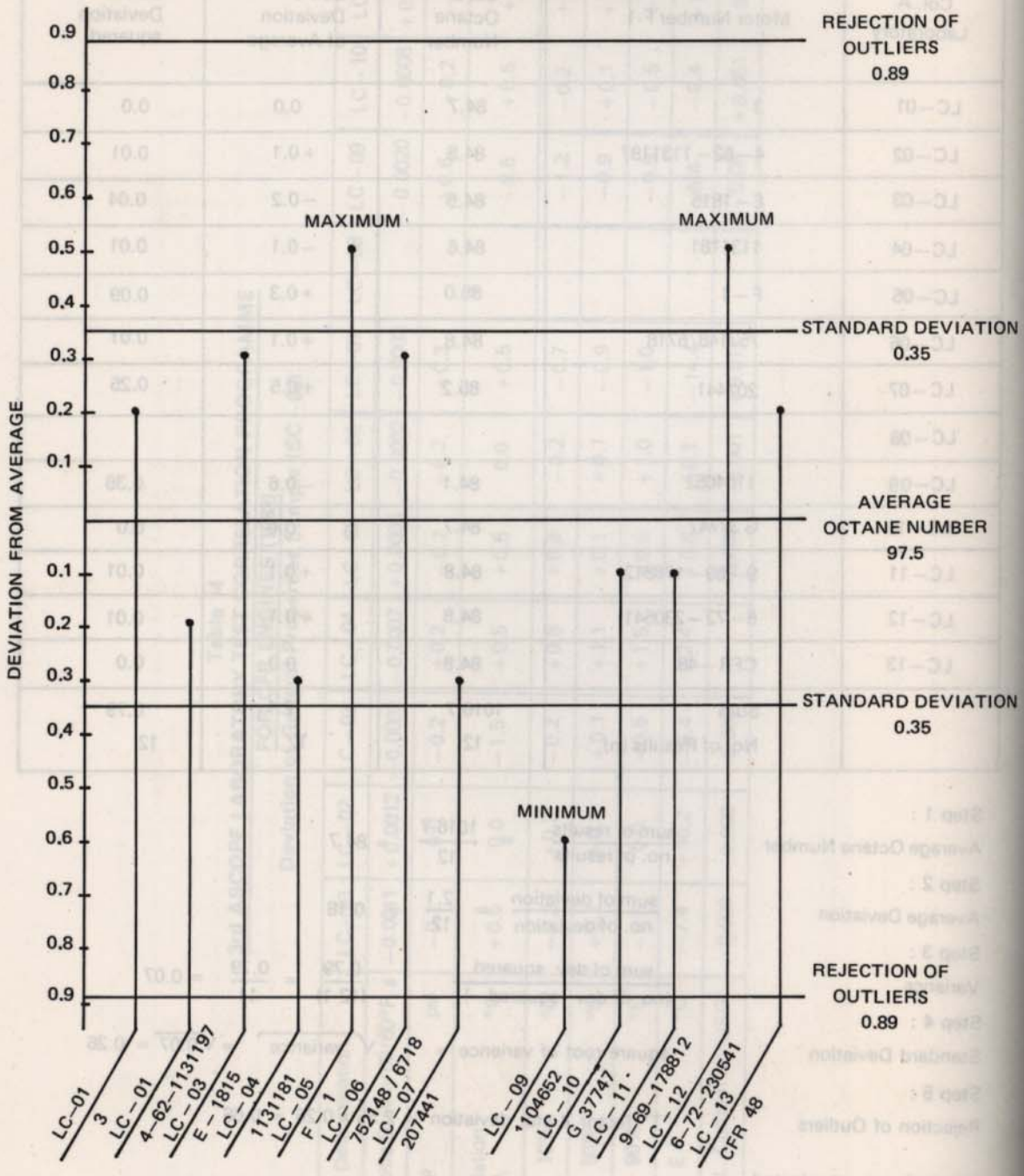

FIG. 2
DEVIATION vs LAB. CODE (SC–02)
CFR 3rd CORRELATION

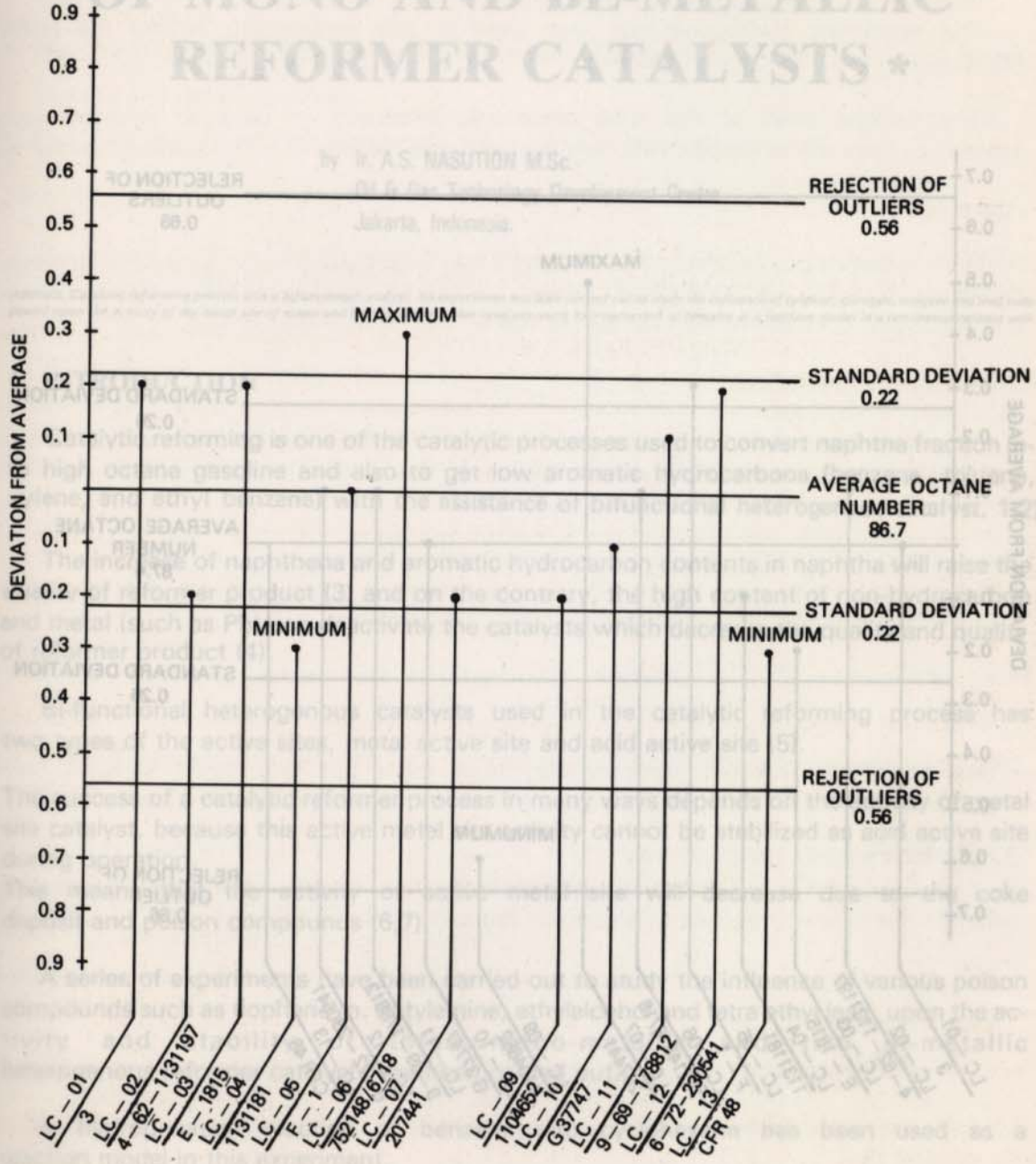

FIG. 3
DEVIATION vs LAB. CODE (SC—03)
CFR 3rd CORRELATION